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SYCAMORE SEED GERMINATION: THE EFFECTS OF PROVENANCE, STRATIFICATION, TEMPERATURE, AND PARENT TREE

Abstract.--Various stratification periods and germination temperatures were applied to sycamore seed collected along the Chattahoochee River from north Georgia to west Florida. Results showed that percent and speed of germination were greater for seed from southern than from northern provenances. Percent and speed of germination increased as temperature increased. The interaction of provenance with stratification was significant only for germination speed. When seed were kept separate by parent tree, seed from isolated trees had poorer germination than did seed from trees growing near other sycamores.

Sycamore seed mature in mid-fall and remain on trees until late winter or early spring, when the fruit disintegrate and seed are dispersed by wind. Mature seed are often in a state of apparent physiological dormancy, which can be broken by stratification. There is some evidence that dormancy is released by afterripening while the fruit overwinter on the trees.[1]

The tests reported here were designed to delineate the effects of temperature and stratification on the germination of sycamore seed collected from five latitudinal provenances on the Chattahoochee River in Georgia and Florida. The work represents the first phase of a study of genetic variation in sycamore within this river system.

SEED ORIGIN

Between December 17, 1965, and January 8, 1966, seed were collected at five points along the Chattahoochee River, the northernmost in the mountains of north Georgia and the southernmost near the gulf coast in Florida (table 1). Within each collection point or provenance, seed were collected from 10 parent trees separated from each other by at least 100 feet. Seed were kept separate by parent tree and were stored at about 10 percent moisture content and 35° F. until the germination study started in April 1966.

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[1]U. S. Forest Service. Woody-plant seed manual. U. S. Dep. Agr. Misc. Pub. 654, 416 pp. 1948.

Southeastern Forest Experiment Station-Asheville, North Carolina

U.S. Department of Agriculture-Forest Service

Table 1.--Locations and descriptions of provenances.

County	State	Latitude	Altitude	Growing season
			Feet	Days frost free[1]
White	Georgia	34°40'	1,500	200
Douglas	Georgia	33°35'	700	230
Stewart	Georgia	32°10'	170	233
Seminole	Georgia	31° 1'	100	250
Liberty	Florida	30°13'	35	264

[1]Source: 1941 Yearbook of Agriculture: Climate and Man. Data are from reports of recording stations nearest to collection points.

Experiment I:

Interaction of Provenance with Stratification Time and Temperature

Methods

The experiment was conducted as a 5 x 3 x 3 factorial. A seed lot for a provenance was composed of about 500 seed from each parent tree. Each seed lot was divided into three sublots, two of which were stratified (one for 2 weeks and the other for 4 weeks). These two stratification periods were staggered so that both ended simultaneously. The third sublot was not stratified. Each sublot was then divided into three parts, and from each part three samples of 100 seed each were selected at random for germination. Each of these sets of three samples was germinated at a different constant temperature (65°, 75°, or 90° F.) in separate petri dishes containing 10 ml. of distilled water.

Stratification was accomplished by moistening the seed, placing them in small polyethylene bags, and then storing them at 40° F. for the specified length of time. The seed were germinated in the dark except for a 30-minute counting period each day. A seed was counted and removed from the dish when the radicle was visible. Observations were made on each sample until zero counts were made on 2 consecutive days. The data on percent germination at 14 days (arcsin transformation) and on number of days to 90 percent of total germination were subjected to an analysis of variance.

Results

The effects of provenance, temperature, and stratification on the two germination parameters were highly significant. The seed from the two southern provenances had higher percent germination than did those from the three northern provenances (table 2). Although the seed from the northernmost provenance germinated slowest and those from the southernmost provenance germinated fastest, there was no clearcut intermediate trend.

As temperature increased, percent and speed of germination increased, but the increment from 65° to 75° F. was greater than the increment from 75° to 90° F. (table 3). For percent germination, the rate of increase was greater for the two southern provenances than for the three northern provenances (table 4).

Table 2.--Percent and speed of germination of seed from five provenances. Means based on data from all temperature and stratification treatments.

Provenance	Germination	Time to 90 percent of total germination
	Percent	Days
White Co.	17.6	6.3
Douglas Co.	18.0	5.3
Stewart Co.	19.5	5.8
Seminole Co.	31.4	5.7
Liberty Co.	29.1	5.2

Table 3.--Percent and speed of germination as influenced by temperature and stratification time. Means based on data from all provenances.

Temperature	Germination after stratification for--				Time to 90 percent of total germination after stratification for--			
	0 week	2 weeks	4 weeks	Average	0 week	2 weeks	4 weeks	Average
	- - - - - - Percent - - - - - -				- - - - - - - Days - - - - - -			
65° F.	11.2	21.2	16.7	16.4	11.1	6.9	10.0	9.3
75° F.	22.9	26.9	23.4	24.4	5.5	4.1	4.4	4.7
90° F.	29.5	27.1	29.1	28.6	3.1	2.8	3.1	3.0
Average	21.2	25.1	23.1		6.6	4.6	5.8	

When the seed were germinated at 65° and 75° F., 2 weeks' stratification improved percent and speed of germination more than did 4 weeks' stratification, which was only slightly better than no stratification (table 3). Stratification had no effect when seed were germinated at 90° F. Only for germination speed was the interaction of provenance and stratification statistically significant (table 5). For the mountain source (White Co.), 4 weeks' stratification gave the faster germination. Seed from other provenances germinated more rapidly after 2 weeks' stratification.

Table 4.--Percent germination of seed from five provenances as influenced by germination temperature. Means based on data from all stratification treatments.

Provenances	Germination at--		
	65° F.	75° F.	90° F.
	----------- Percent -----------		
White Co.	12.9	18.4	21.6
Douglas Co.	13.1	17.9	22.9
Stewart Co.	14.8	21.1	22.6
Seminole Co.	19.3	33.1	41.7
Liberty Co.	21.7	31.4	34.1
Average	16.4	24.4	28.6

Table 5.--Speed of germination of seed from five provenances as influenced by stratification. Means based on data from all temperature treatments.

Provenances	Time to 90 percent of total germination after stratification for--		
	0 week	2 weeks	4 weeks
	------------ Days ------------		
White Co.	7.5	6.1	5.3
Douglas Co.	6.1	4.6	5.3
Stewart Co.	6.9	4.1	6.2
Seminole Co.	5.8	5.1	6.3
Liberty Co.	6.4	3.2	5.9
Average	6.5	4.6	5.8

Experiment II:

Parent Tree Differences

Methods

Experiment II was conducted to determine whether germination varied significantly among seed lots from different parent trees. Three 100-seed samples from 5 of the 10 parent trees in each provenance were stratified for 2 weeks and germinated in the dark at 75° F. Percent germination (arcsin transformation) was analyzed as a nested sampling design.

Results

In contrast to Experiment I, differences among provenances in this experiment were nonsignificant; but individual parent trees showed important differences. As might be expected, seed from isolated trees germinated poorly in comparison with trees growing in stands with other sycamores close by (table 6). Germination of seed from isolated trees ranged from 4.0 to 12.7 percent, whereas germination of seed from trees close to other sycamores ranged from 11.7 to 67.0 percent.

Table 6.--Percent germination and position of parent trees relative to other sycamore trees.

Provenances	Position of parent tree relative to other sycamores	Germination of seed from parent tree
		Percent
White Co., Georgia	Isolated	4.7
	Isolated	4.0
	Surrounded	30.3
	Surrounded	48.3
	Surrounded	36.0
Douglas Co., Georgia	Surrounded	15.7
	Surrounded	19.7
	Surrounded	11.7
	Surrounded	19.3
	Surrounded	20.3
Stewart Co., Georgia	Isolated	5.0
	Isolated	12.7
	Isolated	9.7
	Isolated[1]	11.0
	Surrounded	67.0
Seminole Co., Georgia	Surrounded	20.7
	Surrounded	37.0
	Surrounded	62.3
	Surrounded	53.3
	Surrounded	32.7
Liberty Co., Florida	Surrounded	37.3
	Surrounded	27.9
	Surrounded	49.0
	Surrounded	40.3
	Surrounded	24.0

[1] Parent tree located in an isolated stand of five trees.

DISCUSSION

These data suggest two recommendations of practical importance for growing sycamore seedlings: First, seed should be collected from trees growing in stands with other sycamores. The low germination of seed from isolated trees is consistent with Beland and Jones' report[2]

[2] Beland, J. W., and Jones, LeRoy. Self-incompatibility in sycamore. Ninth South. Conf. on Forest Tree Impr. Proc. 1967: 56-58. 1967.

that sycamore is a self-sterile species. The isolated trees probably received small amounts of pollen from other sycamores and, because self-pollination was ineffectual, they had poor seed set and low germination. However, seed from certain sycamores may have low germination even when the trees are located in stands with other sycamores.

Second, stratification has limited value for seed collected around January 1 in Georgia and north Florida, even though stratification significantly improved germination in certain instances. The critical length of stratification was short (2 weeks). Longer stratification actually reduced germination at the lower temperatures, and rising temperatures quickly compensated for the absence of stratification as well as for excessive stratification. Only the mountain source germinated better after 4 weeks' than after 2 weeks' stratification, but the improvement was slight.

The variation encountered here in percent germination among provenances probably represents differences in locations of individual trees with respect to pollen supply and in weather conditions during pollen flight rather than any permanent differences in seed quality. In Experiment I, differences among provenances were significant; but in Experiment II, where individual trees were kept separate, the effects of provenance were not significant.

Variation in germination speed among provenances followed a pattern reported by Wilcox[3] for sweetgum from similar latitudes in Mississippi and Louisiana. For both species, the southernmost sources germinated faster than the others; and there was no clearcut clinal trend. However, our mountain source was clearly the slowest to germinate. The absence of a clearcut clinal trend from mountain to coast may result from (1) sampling within a narrow range of latitudes, or (2) the fact that seed may have achieved varying degrees of dormancy release (via afterripening on the tree) before collection.

[3]Wilcox, J. R. Sweetgum seed stratification requirements related to winter climate at seed source. Forest Sci. 14: 16-19. 1967.

Charles D. Webb, Plant Geneticist
Forestry Sciences Laboratory
Athens, Georgia

and

Robert E. Farmer, Jr., Plant Physiologist
Tree Improvement Section, Division of Forestry Development
Tennessee Valley Authority, Norris, Tennessee

When this study was made, Farmer was on the staff of the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.